Examining the impact of early childbearing on education, literacy and labour market outcomes in seven developing countries

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Abstract

We examine the impact of early childbearing on education, literacy and labour market outcomes of women in four African countries and three Asian countries, using the Demographic and Health Survey datasets. Cognisant of the endogeneity in this relationship, we identify the effect of teenage motherhood with the individual respondent's age of menarche. We employ 2SLS and bivariate probit models to compare women with early childbearing to their counterparts who choose to have children later in their lives. Aligned with the findings for developed countries in the literature, we find a large, negative and significant marginal effects on the years of education and literacy of adolescent mothers. There is no robust evidence that teenage motherhood has a significant and large direct impact on labour market prospects, but there is a plausible indirect pathway via education and literacy.

1. Background

Every year approximately 16 million teenage girls in developing countries have babies (UNFPA, 2015; Neal, Matthews, Frost, et al, 2015). About 95% of teenage mothers reside in developing countries, yet there are only a handful of studies that study the impact of early childbearing on females in developing countries (UNFPA, 2013b). The lack of evidence on early childbearing in developing countries is a serious weakness because it constrains the design of appropriate local policies and interventions to discourage teenage motherhood.

The available studies on the predictors of teenage motherhood in developing countries find that early childbearing has a consistent and robust association with at least three factors: vulnerability, low education and lack of contraception use (Pradhan, Wynter, Fisher, 2015). We contribute to this literature by carefully examining the causal links between these factors and comparing them across seven developing countries, including three Asian and four African countries.

The link between teenage motherhood and vulnerability is of particular interest because teenage motherhood tends to conspire with vulnerability to function as a gendered poverty trap, enhancing the likelihood that women at the bottom of the income distribution can become stuck in poverty and find it difficult to achieve their full potential. The gendered dimension of this problem relates to social norms about gender affecting many crucial decisions including control of reproductive choices and traditional childrearing roles. In most cases, teenage fathers bear a disproportionately small share of the child-raising responsibilities, allowing them to continue their education without any disruption to their education and with minimal impact on their labour market earnings.

This question can also be viewed through the lens of intersecting or overlapping vulnerabilities: an adolescent mother is young and female by definition, but we also know that they are more likely to be from the lower strata of the socioeconomic distribution. Thus, even before becoming pregnant, many teenage mothers face three intersecting

vulnerabilities: being female, being young, and being poor. Our analysis will address how these vulnerability dimensions intersect with the likelihood of adolescent motherhood and also how poverty affects the prospects of teenage mothers.

We are aware of the limitations of our approach in a context where gendered norms about schooling and labour market outcomes are sufficiently biased these may serve as a binding constraint and prevent us from observing the impact of adolescent motherhood. If young girls are generally discouraged from completing their high school education and if the market for paid work favours male workers, such gender discrimination may overshadow any further bias or disadvantage faced by teenage mothers. In such a case, we may also separately be interested in the gendered impact of teenage motherhood by comparing the education and labour market outcomes of teenage mothers with that of the biological fathers. Data constraints make this infeasible, but it remains an important consideration, especially in contexts where gender discrimination is sufficiently severe that comparisons of education and labour market outcomes between females or mothers may be uninteresting. A cross-country study, including developing countries representative of the full spectrum of gender norms, may be a useful avenue to better understand the role of such macro-level constraint.

1.1 What we know about early childbearing in developing countries

Despite the widespread concern about the impact of adolescent motherhood on poverty alleviation, equity and social mobility in developing countries, a relatively small number of papers have attempted to estimate the causal impact of teenage motherhood on education or labour market outcomes in developing countries.

Almanza and Sahn (2018) examine the impact of early childbearing on labour market outcomes in Madagascar using a panel survey. The instrument for early childbearing with community-level access to condoms after controlling for socioeconomic circumstances. They find that early childbearing decreases the likelihood of completing school and

increase the likelihood of dropping out of school. Early childbearing also affected performance on standardised tests for Mathematics and French.

Ardington et al (2014) use a panel data set from a rural district in South Africa to show that teen fertility affected educational attainment. They use a mother fixed effects to control for individual heterogeneity, thus compare between sisters against one another. They find that early teen mothers, who have their first child before the age of 17, have a year less education compared to their counterparts who wait until they are 20 to have their first child. They did not find evidence of selection into teenage pregnancy based on pre-pregnancy differences in school performance or household characteristics. They report that teen mothers are less likely to report condom use and more likely to have older partners compare to other adolescents with the same age of sexual debut.

Marchetta and Sahn (2015) study how young women in Senegal make decisions about their education, their age of marriage, their childbearing and their labour market entry. To achieve this, they estimate a recursive four-equation simultaneous equation model, using the Household Survey on Education and Welfare. They use a sisters fixed effect to address concerns about unobserved heterogeneity. They find that women with more years of completed education are more likely to delaying marriage. They also find that in Senegal the delay of the first birth worked via the delay of marriage.

To the best of our knowledge, only one previous study considered the impact of early childbearing on labour market outcomes in more than one developing country. Azevedo et al. (2012a)[1] examined early childbearing in Latin America and the Caribbean, and found that it was associated with vulnerability and lack of opportunities, and contributed towards a

[1] Other cross-country evidence from developing countries has been provided by Aguero and Marks (2008, 2011) and Caceres-Delpiano (2012). However, these studies do not focus on early childbearing but rather address the relation between fertility decisions and female labour participation. Another cross-country analysis based on developing countries concerns Jensen and Thornton (2003). But they look at the association between early marriage and women' education and well-being in general. As in our case, all these cross-country analyses use the nationally representative demographic and health surveys (DHS) data.

gendered poverty trap in the region. Their work was descriptive and did not attempt to derive a causal impact.

1.2 Mechanisms influencing teenage fertility and schooling decisions

Typically, models of teenage fertility decisions describe it as a rational choice, drawing on the seminal work of Gary Becker on the economics of fertility (e.g. Ribar, 1994; Klepinger, Lundberg and Plotinger, 1999; Hotz et al, 2005). For instance, Ribar (1994) views teenage motherhood as the consequence of a sequence of important choices about sex, contraception and abortion. Using a utility maximisation framework, the teenager's decisions about fertility amounts to balancing various anticipated costs and benefits including those associated with having a child, continued schooling and her labour market prospects. In most such models the preferred age for having a first child is affected largely by the underlying valuation of additional years of education. Having a child increases the opportunity of attending school and in most societies, this burden is still carried disproportionately by females.

While analytical models tend to acknowledge that there is a role for chance through factors such as the likelihood of conception, fecundity and miscarriage, the assumption is usually still that the teenage girl has considerable agency in navigating her life path. These assumptions that not always align with the experiences of teenage girls in developing countries. In developing countries, arranged marriages, coercive sexual encounters and repressive gender norms may severely constrain the choice sets of teenage girls, influencing their reproductive rights, their schooling decisions and later in life, their labour market participation and opportunities.

Child or teen marriage is an extreme, but an apt illustration of such restrictive and misogynist social norms. The early transition to adult responsibilities robs children of their childhood: “Child marriage is a human rights violation that prevents girls from obtaining an education, enjoying optimal health, bonding with others their own age, maturing, and ultimately choosing their own life partners” (Nour, 2006:1644). Field and Ambrus (2008)

show that early marriage has a significant negative impact on the health and economic outcomes of women in Bangladesh. As expected, child or teen marriages are more prevalent in societies with conservative gender norms and are associated with higher levels of gender inequality (Raj et al., 2009). In regions where child marriage is a norm, teenage childbearing is 5 to 10 times higher. Nine in ten adolescent pregnancies occur to girls who are already married (World Health Organisation, 2008).

2. Identifying the causal impact of teenage motherhood

It is complicated to disentangle the causal mechanisms linking early childbearing, educational attainment and labour market outcomes. In the preceding section, we identified three potential ways in which endogeneity could distort the results. Both sources of unobserved heterogeneity would create an upward bias in OLS estimates, while the source of measurement error and misreporting would lead to a downward bias in OLS estimates. Based on the empirical literature, we conjecture here that there are three potential sources of endogeneity that could bias our estimates and each of these are discussed in turn below.

2.1 Individual motivation and aspirations as unobserved heterogeneity

The fertility decisions of teenage girls are influenced by their anticipated labour market returns to education investment, which would reflect their perceived ability, their confidence and their perceived motivation and reflect their labour market aspirations (Rosenzweig and Wolpin, 1980, Heath 2017; Guo et al. 2018). If a teenager does not expect to gain much from school and thinks she will not do well in the labour market, then leaving school early may not appear to be a large loss. There is also empirical evidence to support this analytical concern: infrequent contraceptive use amongst teenagers are correlated not only with a lack of knowledge of contraception and a lack of access to contraception, but also with poor performance in school, and low career aspirations (Brooks-Gunn and Furstenberg, 1989; Sneed et al., 2001). Due to this unobserved heterogeneity, there are concerns about endogeneity in estimating the impact of teenage fertility on educational and labour market outcomes. We would expect this unobserved heterogeneity to manifest as an upward bias in the OLS estimates.

2.2 Shorter decision horizons and risk-taking as unobserved heterogeneity

Findings from behavioural economics show that teenagers often make short-sighted or risky decisions because they live in the moment and heavily discount the future (Gruber, 2001, Oreopoulos, 2007). Short-sighted, sensation-seeking and egocentric decision making will increase the likelihood of risky or reckless sexual behaviour and early school drop-out (Arnett, 1992). Unprotected teenage sex remains highly prevalent in developing countries, despite the increasing availability and awareness of contraception and amidst the harsh consequences of early childbearing for females (Chandra-Mouli, et al. 2014). We do not capture the individual's tendency towards risky or reckless behaviour and this may be an important source of unobserved heterogeneity, influencing the likelihood to have unprotected sex, the likelihood to drop out of school and short-sighted decision making that influence your labour market prospects. This source of endogeneity would lead to an overestimation of the impact of teenage motherhood on literacy, education and labour market outcomes.

2.3 Inaccurate reporting due to social stigma

Due to the social stigma related to teenage pregnancy and because the survey was administered in-person by a field worker, there may also be a role for measurement error. Teenage motherhood may thus be underreported and such underreporting may be difficult to detect or verify during the day when children are often not at home. This would lead to an underestimation of the marginal effect.

2.4 Previous identification strategies

Hotz, Sanders and McElroy (1997, 2005) estimate the causal impact of early childbearing on the mother’s social prospects and long-term outcomes, using miscarriage as an instrument. They acknowledge that the occurrence of miscarriage is a combination of random and non-random events, but they can control for the influence of non-random

factors such as drinking, smoking, and early contraception, which enables them to estimate lower and upper bounds on the causal impact. This work was extended by Reinhold and Woutersen (2011), who find that such bounds are wide, but informative with the upper bound consistently remaining well below the OLS estimate.

Abortions have also been proposed as an IV, but Ashcraft et al. (2013), Lang and Weinstein (2015) and Fletcher and Wolfe (2009) argue that the loss of a pregnancy is non-random where abortions are available and widely used. However, it has been suggested that this channel of influence can be controlled for by including socio-economic status variables and community fixed-effects.

There are also papers that use a mother fixed effect to capture unobserved heterogeneity shared by siblings (Ardington et al, 2014: Marchetta and Sahn, 2016) but because aspirations and motivation can differ substantially between siblings, it is not clear that this approach alleviates endogeneity concerns.

2.5 Age of menarche as an IV

Instrumentation with age of menarche is less contentious and still widely used. Earlier age at menarche lead to a greater number of fertile teenage years and thus implies a greater risk of becoming pregnant as a teenager. Lower age at menarche implies earlier fertility, which affects the age at first pregnancy and first marriage (Aryal, 2007; Dunbar et al., 2008; Sekhri, 2014). Additionaly, Ajah (2015) and Glynn et al. (2010) shows that there is a positive relationship between age at menarche and first sexual intercourse in Nigeria and Malawi respectively. Ajah (2015) report that in Nigeria girls who reached menarche before 13 were more likely to report being sexually active than those who became fertile after 14.

Ribar (1994) and Klepinger et al. (1999) rely on this instrument to analyze the effects of early childbearing on educational attainment. The credibility of survey information on age of menarche is strengthened by papers showing the women reliably recall when their age of menarche, with reproducibility of self-reported menarche at two different points in time

classified as moderate to strong (Bosetti, et al, 2001; Freedman et al, 2002; Dorn, et al. 2013; Lundblad and Jacobsen, 2017). Field and Ambrus (2008) and Sunder (2016) both used age at menarche as an instrument for the age of first marriage in Bangladesh and Uganda respectively. Both studies find that delaying marriage is associated with improved educational outcomes.

However, there are also concerns about the exogeneity of the age of menarche. A systematic review on non-genetic determinants of the age of menarche finds that there are large variations in age of menarche across ethnic groups, but that considerable uncertainty remains about the reasons for this variation (Yermachenko and Dvornyk, 2014). Kelly, et al (2017) analyses a large 11-year longitudinal study of almost 20 000 households in the UK and confirm that ethnicity and social disadvantage are important predictors of the early age of menarche. They found that for the poor this effect works via higher psychosocial stress and adiposity while it works via higher levels of material disadvantage and adiposity for ethnic minority groups. (Kelly, et al, 2017). Controlling for ethnic group fixed effects and socio-economic circumstances should thus effectively eliminate non-random variation in age of menarche.

2.6 Identification strategy

To take account of the sources of endogeneity that can bias our results, we estimate the impact of teenage motherhood on years of education, literacy and labour market outcomes using the recursive simultaneous bivariate probit model as the main empirical strategy.[2] This model is formulated as follows:

$$y_i^* = \delta + \beta_1 TM_i + \beta_2' X_i + u_i \quad (1)$$

(2)

[2] This model has received much support from recent investigations. In particular, Li et al. (2019) recommends the use of this model as it is easy to be implemented and the results are readily interpreted from a partial identification perspective.

$$TM_i^* = \eta + \theta_1' X_i + \theta_2' Z_i + \varepsilon_i$$

where i refers to the individual, δ and η are the constant terms of the model, y_i^* and TM_i^* are latent variables and y_i and TM_i are binary variables that satisfy the rule:

$$\begin{cases} y_i = 1 \; if \; y_i^* > 0 \\ y_i = 0 \; if \; y_i^* \leq 0 \end{cases}$$

and

$$\begin{cases} TM_i = 1 \; if \; TM_i^* > 0 \\ TM_i = 0 \; if \; TM_i^* \leq 0 \end{cases}$$

y is the outcome of interest and refers either to education or the labour market outcomes. TM is the endogenous dummy variable and refers to teenage motherhood (defined as whether the individual had a child before the age of 18) and takes on the value of 0 or 1. X and Z are the set of exogenous characteristics. The error terms are u and ε. We assume that they are independent of (X, Z) but are correlated and follow a bivariate normal distribution with zero mean and a variance-covariance matrix given by

$$V\binom{u}{\varepsilon} = \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \qquad (3)$$

The parameter ρ is the correlation coefficient. Probit estimation based on equation (1) will not consistently estimate $(\delta, \beta_1, \beta_2')$ because of the potential correlation between TM and u induced by the correlation between ε and u. However, in the case where ρ is not statistically different from 0, TM and u are uncorrelated and TM can be considered as exogenous in the structural equation.

Under the assumption that (u, ε) has a bivariate normal distribution, the joint probabilities that enter the log-likelihood function are fully determined and are given by:

$$P(y = 1, TM = 1) = \Phi[\delta + \beta_1 + \beta_2' X, \eta + \theta_1' X + \theta_2' Z, \rho],$$

$$P(y = 1, TM = 0) = \Phi[\delta + \beta_1 + \beta_2' X, -(\eta + \theta_1' X + \theta_2' Z), -\rho], \qquad (4)$$

$$P(y = 0, TM = 1) = \Phi[-(\delta + \beta_1 + \beta_2' X), \eta + \theta_1' X + \theta_2' Z, -\rho],$$

$$P(y = 0, TM = 0) = \Phi[-(\delta + \beta_1 + \beta_2' X), -(\eta + \theta_1' X + \theta_2' Z), -\rho],$$

where $\Phi[.]$ is the cumulative bivariate normal distribution. Marginal effects are computed using the conditional mean function $E[y|X, Z]$ and taking the average of marginal effects of all individuals. These effects may be viewed as global effects particularly for variables present in the two equations.[3]

Initially introduced by Maddala (1983), the recursive bivariate probit model is widely used in empirical studies and is applied in various disciplines of economics. See for instance Jones (2007), Balia and Jones (2008) and Fichera and Sutton (2011) for health economics; Carrasco (2001), Bryson et al. (2004) and Morris (2007) for labor economics; Evans and Schewab (1995), Neal (1997) and Altonji et al. (2005) for education economics and Deadman and MacDonald (2003) for economics and law to name a few.[4]

Maddala (1983) and Greene (1998) suggest that the endogenous variable on the right-hand side of (1) can be ignored in the estimations. This stems from the fact that the endogenous nature does not affect (or is not relevant for) a full information maximum likelihood estimation of this recursive simultaneous model. However, this is not the case when using ordinary least squares as ordinary least squares rely on sample moments calculations and can lead to inconsistent estimates in the presence of simultaneity (Greene 2012).

Recent studies have thoroughly investigated the identification issues related to the recursive bivariate probit model. Wilde (2000)'s argument for which under the multivariate normal distribution, exclusion restrictions are not necessarily required to achieve identification in the model if equations (1) and (2) contain at least one varying exogenous regressor has been recently rejected by most theoretical studies. See for example Mourifié and Méango (2011), Han and Vytlacil (2017) and Han and Lee (2019). In contrast, they

[3] For more details regarding the derivation of the coefficients that maximize the log-likelihood function and the computation for marginal effects, see Greene (2012).

[4] Other contributions include Holly, Gardiol, Domenighetti, and Bisig (1998), and Daniele Fabbri, Monfardini, and Radice (2004).

demonstrate that exclusion restrictions are necessary and sufficient to identify the parameters of the model. Additionally, as pointed out by Li et al. (2019), exclusion restrictions may also improve identification in case of distributional misspecification. In order to take into account these issues, we deal with exclusion restrictions allowing Z to contain at least one exogenous variable not included in X.

We also estimate the impact of teenage motherhood on years of education, literacy and labour market outcomes with a 2SLS approach as in Field and Ambrus (2008), Fletcher and Wolfe (2009), and Caceres-Delpiano (2012).

The requirement for the IVs for 2SLS and the exclusion restrictions for our bivariate probit models are that they need to have a relationship with the likelihood of teenage motherhood, but no direct relationship with education or labour market outcomes. Based on the literature, we propose the respondent's age of menarche as an IV/exclusion restriction for teenage motherhood. The literature shows consistent non-random variation in age of menarche based on ethnic group and socio-economic circumstances (Yermachenko and Dvornyk, 2014; Kelly, et al, 2017). We therefore control for non-random variation in the IV/exclusion restriction, we add average parental education for the community and fixed effects for ethnic groups to the models.

Our proposed instrument has a very strong relationship with our endogenous variable, which is a good start. See Figure 1A in the appendix for the Kernel-weighted local polynomial smoothing graph comparing the relationship between the likelihood of teenage motherhood and how many years before 18 the girl experienced menarche. For the sake of transparency, we also include the kernel density graphs for the age of menarche for each country (Appendix Figures 1B).

We aim to estimate simple reduced form models, so we add only controls for age, urban location, religious affiliation and ethnicity. We estimate the impact of teenage motherhood on three outcomes: years of education, literacy and remunerated employment. Years of education and remunerated employment are both self-reported. Literacy is a binary variable

based on a reading test, coded as a 1 in cases where the woman was assessed to find reading easy and 0 if she could not read at all or found it very difficult to read.

In the appendix, we show the impact of teenage marriage on the same set of outcomes. As proposed by Field and Ambrus (2008), we use the age of menarche as an instrument for early marriage.

3. Demographic and Health Surveys from seven developing countries

This study will use eight Demographic and Health Surveys from seven countries in Sub-Saharan Africa and Asia. The Demographic and Health Surveys (DHS) Program has been widely used across a range of developing countries and one of the advantages of using this data is that it is comparable over countries and over time. This comparability has been achieved via the development of standard model questionnaires (and written descriptions motivating why certain questions or sections have been included). These model questionnaires — which have been reviewed and modified in each of the six phases of the DHS Program — form the basis for the questionnaires that are applied in each country. Typically, a country is asked to adopt the model questionnaire in its entirety but can add questions of particular interest. However, questions in the model can be deleted if they are irrelevant in a particular country.

DHS are nationally representative population-based surveys with large sample sizes (usually between 5,000 and 30,000 households). There are three core questionnaires in DHS surveys: a household questionnaire, a women's questionnaire, and a men's questionnaire. The women questionnaire is administered to a subsample of women aged 15 to 49 and contains questions on employment status, birth history, current and future contraceptive use, fertility preferences and socio-economic and marital status.

Due to our reliance on the age of menarche for instrumentation, we will only include the DHS surveys where the age of menarche was available. We excluded surveys where we could not create the required controls for our models. We also excluded the later waves of

the Philippines DHSes (2013) because the questionnaire was not sufficiently similar to the other country surveys. This left us with eight country datasets: Cameroon 1991, Philippines 2003, Philippines 2008, Ugandan 2000, Uzbekistan 1996, Kyrgyz Republic 1997, Ghana 1998 and Gabon 2000. We excluded women younger than 19 because two of the key outcomes, teenage motherhood and completion of high school would not be fully determined prior to reaching the age of 19.

4. Correlates of teen motherhood

It is clear that teen mothers are different from their counterparts who had children later in their lives. Appendix Table 3 shows that the likelihood of being a teenage mother is significantly higher amongst those who live in urban locations (0.47 vs 0.42), reside in African countries (0.80 vs 0.33) or are poor (0.42 vs 0.22). Teenage mothers have parents with fewer years of education (6.3 vs 8.6 years).

Perhaps of greater concern for this paper, we find that while women who had children early are significantly more likely to have ever worked (0.70 vs 0.63) there is not a significant difference in the likelihood of currently doing paid work (0.57 vs 0.56). Teenage mothers tend to have significantly fewer years of education (5.06 vs. 8.77) and lower levels of literacy (0.54 vs 0.80).

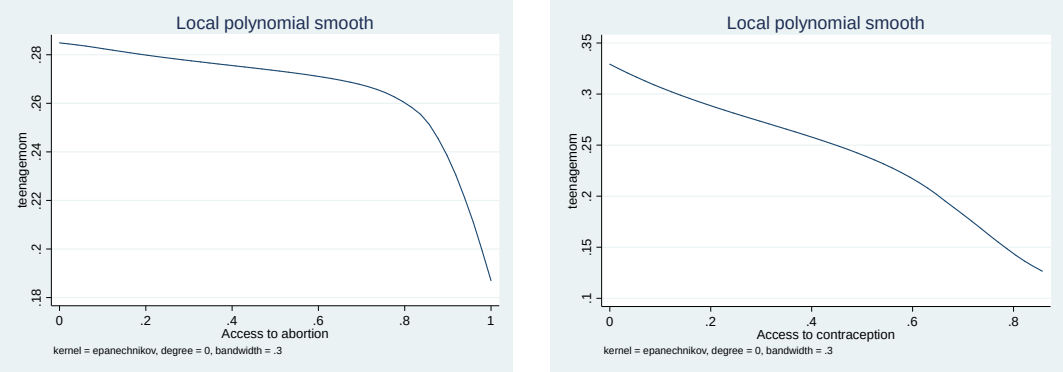


Fig 1. Local polynomial comparing the likelihood of teenage motherhood by local access to abortions and contraception

As expected, there are a number of variables such as contraception and teen sexual activity that have very strong relationships with teenage motherhood as shown in Figure 1, but we cannot include these variables in our causal models because they are endogenous. The kernel-weighted local polynomial smoothing graph above shows that there is a very strong negative relationship between local access to contraception and teenage motherhood. Note that our implementation of local access to contraception is estimated by the share of women who say that they are currently using contraception, so it also incorporates acceptability. One of the difficulties is of course that this measure is reliant on the demand for contraception, which is derived from the demand for sex without reproductive consequences. Figure 1 above shows that local access to abortions does not have a similar gradually downward sloping negative relationship with teenage motherhood. It should also be noted that the area where we do see a downward sloping relationship (between 0.8 and 1) has less than 1% of the observations.

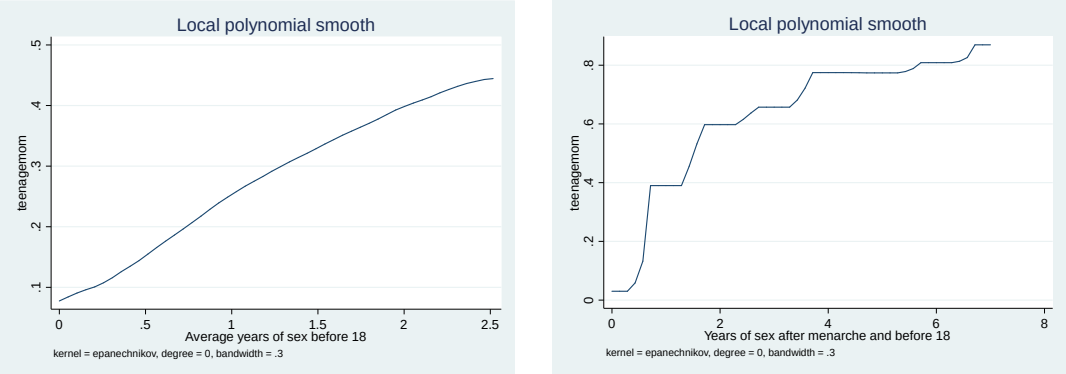


Fig 2. Local polynomial comparing the likelihood of teenage motherhood by the average years of sexual activity before 18 vs. average years of sexual activity before 18 and post-menarche

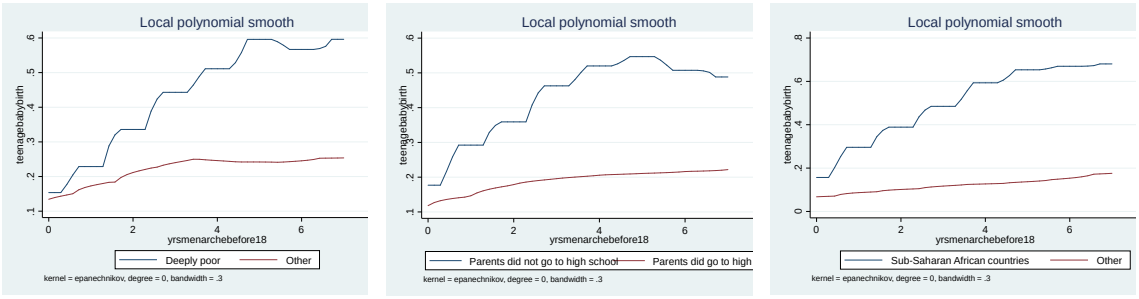


Fig 3. Local polynomial comparing the likelihood of teenage motherhood for years of menarche before 18, for vulnerable vs. non-vulnerable subgroups

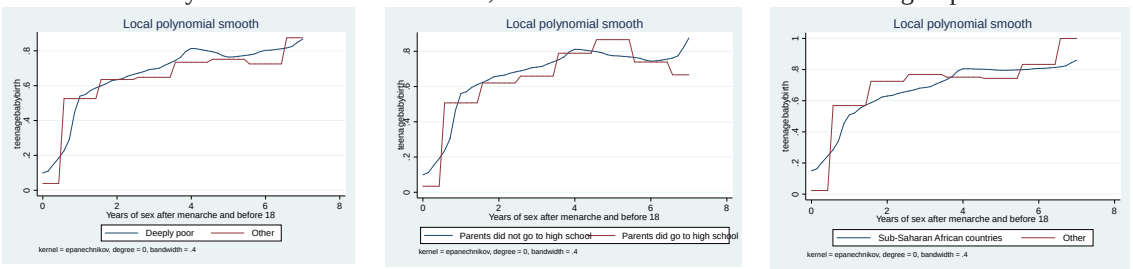


Fig 4. Local polynomial comparing the likelihood of teenage motherhood for fertile (post-menarche) sexually active years before 18, for vulnerable vs. non-vulnerable subgroups

Figure 2 shows that teen sexual activity has a strong relationship with teenage motherhood. Figure 3 and 4 suggest that teen sexual activity may intermediate many of the other observed relationships with teenage motherhood, including its positive relationship with living in an African country, Christianity and lower parental education (see Figure 3). Once we add teen sexual activity to the age of menarche variable (i.e. to capture sex before 18 after menarche) there is little evidence of a residual relationship between these variables

and teenage motherhood (see Figure 4). Teen sexual activity is highly endogenous so we choose to exclude it from our core set of regression models.

Our descriptive analysis also suggests that early marriage matters. Early marriage and childbearing both mark a transition where a child becomes a caregiver and takes up the responsibility for looking after her own household. These additional responsibilities will often interfere with further investments in your education and your career. Also, it has been shown that early marriage is an important enabler and predictor of early childbearing (World Health Organization, 2008; Mmari & Sabherwal, 2013). There are however many important differences too, including the required parental consent for teen marriage, and thus we may expect there to be separate mechanisms that determine early childbearing outside of marriage and early childbearing within marriage.

Table 1: Reason women stopped attending school

	Gabon	Uzbekistan	Kyrgyzstan
Pregnancy	42.98	0.23	0.65
Marriage	3.61	13.27	41.5
Need to look after children	2.4	2.6	4.72
Family needs help	3.03	3.38	8.96
Could not afford school	30.51	N/A	N/A
Need to earn money	1.77	3.88	8.73
Graduated	0.36	73.44	25.06
Did not pass exams	N/A	N/A	6.06
Did not like school	6.01	1.1	1.48
School not accessible	1.4	1.99	0.43
Health problems	7.94	0.11	2.41

In Table 1 above we examined the most important reasons why women say they stopped attending school. This question was asked in three of our eight DHS surveys. Answers vary substantially between these three countries: in Gabon, 43% of women leave school because they are pregnant, while this is rarely (lower than 1%) given as a reason for leaving school by women in Uzbekistan and Kyrgyzstan. Conversely, 42% of women in Kyrgyzstan report that they left school because they marry, while represents only 13% of the reason for school leaving in Uzbekistan and less than 4% in Gabon.

Table 2: Years of education vs. marital status and motherhood at 18, by country

	Married at 18, with kids	Married at 18, no kids	Unmarried, with kids	Unmarried, without kids	Total
Cameroon	2.07	2.17	5.93	5.83	3.01
Ghana	4.44	4.8	5.01	6.08	5.24
Gabon	5.97	6.14	7.43	8.06	6.94
Uganda	3.13	3.42	5.1	5.44	3.95
Kyrgyzstan	9.9	10.25	9.71	11.17	10.87
Philippines 2008	7.13	8.21	8.32	10.61	9.73
Philippines 2003	6.62	7.45	6.52	9.97	9.06
Uzbekistan	9.98	10.04	10.87	10.89	10.59
Full sample	5.16	6.65	6.71	9.64	7.92

In Table 2 we explore the respective importance of teen marriage vs teen childbearing in our sample, by considering the average number of years of education by comparing women who were teen brides, but not teen moms and women who experienced the reverse, namely, they were teen moms, but not teen brides. In all cases, teens who were both brides and mothers had the lowest level of years of education, while women who were neither teen brides nor teen mothers had the highest years of education. Although clearly not causal, the intention behind the comparison of teen brides and teen mothers is to give some sense of the relative burden it places on education. In most cases, teen brides pay a bigger price than teen mothers, except in the cases of Kyrgyzstan and the 2003 Philippines survey. For this reason, we have supplemented our teen motherhood models with a set of models that also examine the impact of teen marriage on education and labour market prospects. These results have been placed in the appendix to not disrupt the flow of the paper. Appendix Table 4 shows that teenage marriage has an education impact that is a similar order of magnitude than that of teenage motherhood, but the effect of teenage marriage endures for longer because it also has a large negative impact on the labour market prospects of the women whereas we find no robust evidence of teenage motherhood having an impact on paid work.

5.1 Impact of early childbearing on years of education and literacy

Table 3 below shows the results of the OLS, 2SLS and bivariate probit models for estimations of the marginal effects of teenage motherhood on years of education and literacy.

We see that the coefficient on teenage motherhood is significant in both the OLS and the IV models, but smaller for OLS regressions that it is for the IV (-1.22 vs. -1.53), which would be aligned with the measurement error formulation of the endogeneity problem. The first stage for the IV is shown in Table 3: the instrument is significant and has the expected positive coefficient. The low p-value of 0.00 across the tests suggest that we can reject the hypothesis of weak instruments.

The causal effect is large: teenage mothers lose a year and a half of education. Looking at the marginal effects of literacy, the bivariate probit model shows that teenage mothers are 0.19 percentage points less likely to read well. Using the Wald test to consider the hypothesis that rho is zero, we reject the hypothesis of independence for education equation and the motherhood equation, confirming that concerns about endogeneity were valid (Chi2(1) = 62.63; Prob > chi2 = 0.00). We follow Guilkey and Lance (2014) in testing the validity of the exclusion restrictions: the exclusion restriction has a significant coefficient and the Wald test comparing this model with the full nested model (including our instrument in the second stage) reject the inclusion of age of menarche in the main literacy equation (Chi2(1) = 2.99; Prob > chi2 = 0.0837).[5]

The covariates have the expected signs and are consistent across the three models: average parental education of the community, urban location and being Christian are associated with higher education and literacy. Older women are less likely to have higher education

5 We need to run the full nested model without weights because it will not converge with weights. Without the exclusion restriction, it may often be difficult to achieve convergence and this is a weakness of the proposed test.

and literacy. The country marginal effects are large and significant showing that the countries have different experiences.

Table 4 shows the country-specific models. In line with what was suggested by the descriptive statistics as well as the large and significant country dummies, we find that there is considerable country-specific heterogeneity. The models below show that there appears to be a regional split, with the four Sub-Saharan African countries having low current levels of education and literacy and demonstrating the highest impact of teenage motherhood.

Table 3: Impact of teenage motherhood on years of education and literacy

	OLS Years of education	**IV Years of education**	**Bivariate probit for literacy (marginal effects)**
Teenage motherhood	-1.22***	-1.53***	-0.19***
Age of woman	-0.06***	-0.06***	-0.004***
Urban	0.62***	0.62***	0.05***
Average parental education	0.54***	0.53***	0.03***
Observations	31110	31110	31110

*Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

Table 4: First-stage regression of teenage motherhood

	Coef.	**P-value**
Years of menarche before 18	0.03	0.00
Age of woman	0.00	0.29
Urban	-0.02	0.02
Average parental years of education for community	-0.01	0.00
Diagnostics	**Score**	**P-value**
Partial R-squared of excluded instruments	0.0185	0.00
Cragg-Donald N*minEval stat.	587.66	0.00
Anderson canon. corr. likelihood ratio stat	582.18	0.00
Number of observations	31110	
Number of clusters	385	

5.2 Impact of early childbearing on paid work

Table 5 shows the marginal effects of the bivariate probit model for paid work. Teenage motherhood has no causal impact on paid work, but we find a significant coefficient on literacy and years of education, suggesting that the impact of teenage motherhood on paid employment, works via this channel. The Wald test fails to reject the hypothesis of independence of the two equations. For the sake of consistency and to err on the safe side, we retain the bivariate specification when we run the country-specific equations. We test the validity of the exclusion restrictions and find that the exclusion restriction has a significant coefficient. We run a Wald test on a full nested model including the instrument in the paid work equation and the inclusion of the instrument in the main paid work equation is rejected (Chi2(1) = 4.63; Prob > chi2 = 0.03).

The country-specific regressions on paid work in Table 6 reveal patterns that are in many ways similar to the country-specific models of years of education and literacy discussed earlier. Again, there appears to be a divide between the African countries and the other countries that are more advanced with higher levels of secondary education. The only negative and significant marginal effects on paid work are for two Asian countries, the Philippines and Uzbekistan.

Table 5: Impact of teenage motherhood on paid work (marginal effects)

	(1)	(2)	(3)
Teenage motherhood	-0.05	0.07	0.02
Urban	0.01***	0.01***	0.01***
Age of woman	0.05***	0.03***	0.05***
Years of education		0.02***	
Literacy			0.09***
Observations	31110	31110	31110

*Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

Table 6: Impact of teenage motherhood on years of education, literacy and paid work across seven countries

	Cameroon	Ghana	Gabon	Uganda	Sub-Saharan Africa	Philippines	Uzbekistan	Kyrgyzstan
Teenage motherhood marginal effects for years of education	-4.36***	-2.77***	-1.30	-5.51***	-3.87***	7.30***	4.30**	11.70
Teenage motherhood marginal effects for literacy	-0.245***	-0.23***	-0.35***	-0.40***	-0.35***	0.06	-0.29	No convergence
Teenage motherhood marginal effects on paid work	0.03	0.02	0.08	-0.04	-0.03	-0.29***	-0.10	-0.56***
Descriptive statistics for cross-country comparison of context								
Average years of education	3.20	5.23	6.91	4.00	4.94	9.38	10.59	10.89
Average level of literacy	0.30	0.45	0.76	0.45	0.51	0.91	0.94	0.96
Observations	1950	2825	3035	3680	11491	14817	2482	2319

*Notes: All models include fixed effects for religious affiliation and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

6. Is teenage motherhood a heavier burden for vulnerable women?

Our concerns about vulnerability and intersectionality prompt us to consider whether teenage pregnancy may have a larger effect on vulnerable subgroups where the average parental education is below secondary school. We also consider whether our results vary by age cohort, comparing women 25 to 34 with women aged 35 to 49.

When examining the relative burden of teenage motherhood, it is important to take account of the age at which the first birth occurred because otherwise, we could be concerned that we are not comparing like with like; that our evidence of a larger impact of teenage motherhood for vulnerable subgroups may merely be due to a greater share of women with very early childbearing. We would expect a greater adverse impact when a girl's childhood is truncated at the age of 14 than when it happens at 17. A 17-year old would be more mature and closer to school completion. Indeed, Ardington et al (2014) show that in rural South Africa, teenage mothers who have their first child very early face an increased risk of school drop-out (cf. other teenage mothers). In the analysis below we, therefore, take account of such differences and consider the impact of the years of teenage motherhood on education, literacy and paid work. The models are identical to those in section 8 and 9, apart from the discussed change in how we define our variable of interest and the focus on the heterogeneity of effects between subsamples. The paid work models include controls for both education and literacy.

Table 7 below shows that the marginal effects of an extra year of teenage motherhood are larger for more vulnerable groups – across all three outcomes. We also see that an additional year of teenage motherhood has a larger marginal effect on education and literacy for mothers aged 25 to 34 cf. the older cohort. By contrast, we find a positive and significant effect of an additional year of teen motherhood on the likelihood of doing paid work. It is concerning that marginal effects of an additional year of teenage motherhood on educational attainment is large, positive and significant for the less vulnerable subgroup and for the older cohort.

Table 7: Impact of years of teenage motherhood, comparing vulnerable groups and age cohorts

	Education	Literacy	Paid work
Full sample	-0.02	-0.06***	0.02
	(-0.22)	(-6.26)	(1.50)
More vulnerable	-0.39***	-0.06***	0.01
	(-4.81)	(-5.62)	(1.02)
Less vulnerable	0.62***	-0.03**	0.02
	(3.23)	(-2.04)	(0.92)
Younger than 35	-0.30***	-0.07***	0.05**
	(-2.83)	(-5.57)	(2.55)
Older than 35	0.34**	-0.04***	-0.001
	(2.53)	(-2.84)	(-0.07)

*Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

7. Assessing robustness of identification strategy

Exogeneity assumptions are not directly testable and motivated by a combination of analytical arguments and the absence of any empirical evidence showing a relationship or a pathway whereby the instrument may be correlated to the unobserved errors.

We know that while the age of menarche is largely determined by genetic factors, it is also influenced by social and environmental factors that determine body size, nutrition and stress. We have motivated our model identification strategy based on studies that show that ethnicity and social disadvantage capture the most prominent social-environmental variations in age of menarche that will also influence teenage motherhood. However, this may not be convincing to all readers and we, therefore, examine the robustness of our findings with two sets of further checks.

We consider how whether our marginal effects estimates change when we add a set of health indicators that reflect long-term differences in body size, nutrition, stress and health. Additionally, we will also employ approaches proposed by Conley et al (2012) and Nevo

and Rosen (2012) to examine how our estimates are affected when we relax the assumption of perfect exogeneity.

7.1 Robustness checks with health indicators

We test the robustness of our model by adding additional controls for social and environmental influences on the age of menarche. There is evidence that age of menarche is affected by body size, nutrition, stress and health (see among others Kaplowitz et al. 2001, Opare-Addo et al. 2012 and Pierce et al. 2012) and that health indicators can be reflective of long-term differences in body size, nutrition, health and stress levels. These rationale is thus that by adding health indicators we capture some of the variations in stress levels, nutrition, health and body size that existed when the respondent was a young girl, and in this way, through adding additional controls for social and environmental influences on age of menarche, improve the strength of the exogeneity assumption.

We have information on current weight and height for five countries in our sample: Gabon, Ghana, Kyrgyzstan, Uganda and Uzbekistan. We have information on haemoglobin and anaemia for three countries in our sample: Kyrgyzstan, Uganda and Uzbekistan. Appendix Tables 5 to 11 show that our results are robust to the inclusion of these variables. Similarly, when examining the case of paid work, the marginal effect sizes do not change substantially when nutritional variables are included in the regressions, but the effect does become marginally significant.

7.2 Relaxing assumption of perfect exogeneity

We also examine the impact of relaxing the assumption of perfect exogeneity, employing strategies proposed by Conley et al (2012) and Nevo and Rosen (2008) to estimate alternative upper and lower bounds for estimates. The reliance on assumptions about the way in which and the extent to which the instrument may deviate from exogeneity is a weakness of both these approaches, but it is encouraging that simulation tests show that these approaches are reliable and perform well (Clarke & Matta, 2018).

These strategies have been designed for use with traditional IV models, so we revert to our years of teenage motherhood model specification – introduced in section 6– to consider the robustness of our instruments in the literacy regressions. The other two outcomes are not significant for the years of teenage motherhood specification so we do not include them in these tests. We follow Sunder (2016) in employing Conley et al. (2012)'s Union of Confidence Intervals approach. The key parameter is γ, which captures the coefficient on the instrument Z in the second stage equation. The IV specification normally requires that we assume that $\gamma=0$, thus the value of γ reflects the extent to which the exogeneity assumption is violated. In our robustness checks with the Conley et al (2012) algorithm we consider the extent to which we can relax the exogeneity assumption whilst preserving an upper bound estimates that lies below. In section 10 we saw that for the full sample the initial confidence intervals for the marginal effects of the years of teenage motherhood marginal effect lie between the lower bound of -0.07 and the upper bound of -0.04. We find that the confidence interval stays negative for γ of 0.005 and below.

An alternative approach, proposed by Nevo and Rosen (2012), replaces the instrument validity assumption with two assumptions: i) that the correlation of the instrument and the unobservable error term is in the same direction as that between the endogenous variable and the error term and that the instrument is less endogenous than the instrumented endogenous variable. Because the correlation between the endogenous variable and our IV is positive, only upper bound confidence intervals are estimated under the default assumptions. The imperfect IV upper bound coincides with the initial upper bound. We also relax the assumption that the correlation is in the same direction, which yields a lower bound estimate of -0.02.

8. Conclusion

The level of teenage motherhood varies across countries but is high, with 25% of respondents reporting that they had their first child before the age of 19. Furthermore, our work shows that early childbearing has a significant and sizeable impact on years of education and literacy and via this avenue plausibly also on labour market prospects, which may contribute to a gendered poverty trap. These effects may work against programmes to promote gender equity in schooling attendance, attainment and outcomes. Ensuring safe and affordable access and to contraception and raising awareness to raise the levels of social acceptability of contraception amongst sexually active teenagers would be an important first step, but a broader set of policies and reforms would be required to respond to this problem.

Appropriate policy solutions would vary across countries. The findings hold for the pooled sample of three Asian and four African countries, as expected, we also find considerable differences by country in how early childbearing affects the lives of women. The divide in the experiences of the African countries and the non-African countries may be because of the changing constraints as the economy of a country advances, following a curve where initially restrictive social norms may be so binding that early childbearing makes little discernible difference to the limited options available to females. Then, as a society develops and becomes more open towards female education, the impact of teenage pregnancies may start to show in educational attainment. In the last phase, society would prioritise female education sufficiently to create effective support mechanisms and solutions to enable females to study while having a young baby. At this stage, the observable effect of teenage motherhood on education may again be small or negligible but for entirely different reasons than in the earlier development stages.

On another point, the analysis demonstrates the usefulness of including the age of menarche in household surveys. Sommer (2013) has shown that very few household surveys include the age of menarche in their questionnaires and has argued that given the public health importance of this variable and the clear evidence of its credibility and reliability, more surveys should include it.

References

Aguero, J. and M. Marks (2008): "Motherhood and Female Labour Force Participation: Evidence from Infertility Shocks," *The American Economic Association*, Papers and Proceedings of the One Hundred Twentieth Annual Meeting of the American Economic Association, 98(2), 500-504.

Aguero, J. and M. Marks (2011): "Motherhood and Female Labour Supply in the Developing World: Evidence from Infertility Shocks," *Journal of Human Resources*, 46(4), 800-826.

Ajah, L. O., Onubogu, E. S., Anozie, O. B., Lawani, L. O., Iyoke, C. A., Onwe, E. O., & Ajah, M. (2015): "Adolescent reproductive health challenges among schoolgirls in southeast Nigeria: role of knowledge of menstrual pattern and contraceptive adherence." *Patient preference and adherence*, 9, 1219.

Altonji, J.G., Elder, T.E and Taber, C.R (2005): "An Evaluation of Instrumental Variable Strategies for Estimating the Effects of Catholic Schooling," *The Journal of Human Resources*, 40, 791–821.

An, C. B., Haveman, R. H. and B. L. Wolfe (1993): "Teen Out-of-Wedlock Births and Welfare Receipt: The Role of Childhood Events and Economic Circumstances," *Review of Economics and Statistics* 75(2), 195–208.

Angrist, J. and W. Evans (1998): "Children and Their Parents' Labour Supply: Evidence from Exogenous Variation in Family Size," *American Economic Review*, 88(3), 450–577.

Ardington, C., Menendez. A. and T. Mutevedzi (2014): "Early Childbearing, Human Capital Attainment, and Mortality Risk: Evidence from a Longitudinal Demographic Surveillance Area in Rural KwaZulu-Natal, South Africa," *Economic Development and Cultural Change*, 281-317.

Arnett, J. (1992): "Reckless Behavior in Adolescence: A Developmental Perspective." *Developmental Review,* 12, 339-373.

Aryal, T. R. (2007): "Age at first marriage in Nepal: differentials and determinants*" J Biosoc Science*, 39(5).

Ashcraft, A., Fernandez-Val, I. and K. Lang (2013): "The Consequences of Teenage Childbearing: Consistent Estimates when Abortion Makes Miscarriage Non-random," *Economic Journal*, 123, 875-905

Assini-Meytin, K. and K. Green (2015): "Long-term consequences of adolescent parenthood among African American urban youth: A propensity matching approach", *J Adolesc Health*," 56(5), 529–535

Azevedo, J. P., Favara, M., Haddock, S. E., Lopez-Calva, L. F., Muller, M. and E. Perova (2012a): "Teenage pregnancy and opportunities in Latin America and Caribbean," World Bank

Azevedo, J. P., Lopez-Calva, L. F. and E. Perova (2012b): "Is the Baby to Blame? An Inquiry into the Consequences of Early Childbearing", World Bank, WP6074

Ballia, B. and A. M. Jones (2008): "Mortality, lifestyle and socio-economic status," *Journal of Health Economics*, 27, 1–26.

Becker, G. (1993): "Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education," Chicago, IL: University of Chicago Press.

Berthelon, M and D. I. Kruger (2017): "Does adolescent motherhood affect education and labour market outcomes of mothers? A study on young adult women in Chile during 1990 –2013," *Int J Public Health*, 62, 293–303.

Bissel, M. (2000): "Socioeconomic outcomes of teen pregnancy and parenthood A review literature," *The Canadian Journal of Human Sexuality*, 9 (3), 191-204.

Black, S., Devereux, P. and K. Salvanes (2005): "The More the Merrier? The Effect of Family Size and Birth Order on Children's Education," *The Quarterly Journal of Economics*, 120(2), 669-700.

Bloom, D., Canning, D., Fink, G.and J. Finlay (2009): "Fertility, Female Labour Force Participation, and the Demographic Dividend." *Journal of Economic Growth* 14(2):79–101.

Borsch-Supan, A. and V. Hajivassiliou. (1993): Smooth unbiased multivariate probability simulators for maximum likelihood estimation of limited dependent variable models. *Journal of Econometrics* 58: 347−368.

Borsch-Supan, A., V. Hajivassiliou, L. Kotlikoff, and L. Morris. (1992): Health, children, and elderly living arrangements: A multiperiod-multinomial probit model with unobserved heterogeneity and autocorrelated errors. In *Topics in the Economics of Aging*, ed. D. Wise, 79−104. Chicago: The University of Chicago Press.

Bosetti, C., Tavani, A., Negri, E., Trichopoulos, D. and La Vecchia, C. (2001): Reliability of data on medical conditions, menstrual and reproductive history provided by hospital controls. *J Clin Epidemiol* 54(9):902–906.

Bougma, M., LeGrand, T.K. and J-F. Kobiane (2015):" Fertility Decline and Child Schooling in Urban Settings of Burkina Faso, *"Demography*, 52, 281–313

Branson, N., Tanya B.(2018):" Causes and consequences of teen childbearing: Evidence from a reproductive health intervention in South Africa," *Journal of Health Economic*s, 57, 221-235

Bronars, S. and J. Grogger (1994): "The Economic Consequences of Unwed Motherhood: Using Twin Births as a Natural Experiment," *The American Economic Review*, 84 (5), 1141-1156

Brooks-Gunn, J., & Furstenberg Jr, F. F. (1989). "Adolescent sexual behavior." *American psychologist*, 44(2), 249.

Bryson, A., Cappellari, L. and C. Lucifora (2004). "Does union membership really reduce job satisfaction?" *British J. Ind. Relations* 42 (3), 439–459

Caceres-Delpiano, J (2012): "Can We Still Learn Something From the Relationship Between Fertility and Mother's Employment? Evidence From Developing Countries," *Demography* 49, 151–174.

Caceres-Delpiano, J. and M. Simonsenb (2012): "The toll of fertility on mothers' Wellbeing," *Journal of Health Economics*, 31, 752– 766.

Carrasco, R. (2001): "Binary choice with binary endogenous regressors in panel data: Estimating the effect of fertility on female labor participation," *Journal of Business and Economics Statistics* 19 (4), 385–394.

Chandra-Mouli, V., McCarraher, D. R., Phillips, S. J., Williamson, N. E. and Hainsworth, G. (2014): Contraception for adolescents in low and middle income countries: needs, barriers, and access. *Reproductive Health*, 11: 1.

Chevalier, A. and T.K. Viitanen (2003): "The long-run labour market consequences of teenage motherhood in Britain," *Journal of Population Economics* 16(2), 323–343.

Clarke, D. and Matta, B. (2018): "Practical considerations for questionable IVs." *The Stata Journal*, 18 (3), 663−691.

Conley, T.G., Hansen, C.B. and Rossi, P.E. (2012): "Plausibly exogenous," *Review of Economics and Statistics* 94 (1), 260–272.

Cruces, G. and S. Galiani (2004): "Fertility and female labour supply in Latin America: New causal evidence," *Labour Economics* 14, 565– 573

Daniele-Fabbri, D., Monfardini, C. and Radice, R. (2004): "Testing exogeneity in the bivariate probit model: Monte Carlo evidence and an application to health economics," Working paper, Department of Economics, University of Bologna.

Daouli J., Demoussis, M. and N. Giannakopoulos (2009): "Sibling-sex composition and its effects on fertility and labour supply of Greek mothers," *Economics Letters*, 102, 189-191

Deadman, D. and Z. MacDonald (2003): "Offenders as victims of crime?: an investigation into the relationship between criminal behaviour and victimization," *Journal of the Royal Statistical Society,* 167 (1), 53–67.

Diaz, C. and J. Fiel (2016): "The Effect(s) of Teen Pregnancy: Reconciling Theory, Methods, and Findings." *Demography,* 53(1), 85-116.

Dorn, L.D., Sontag-padilla, L. M., Pabst, S., Tissot, A., Susman, E.J. and Eccles, J. (2013): "Longitudinal reliability of self-reported age at menarche in adolescent girls: variability across time and setting." *Dev Psychol* 49(6):1187–1193.

Evans, W.N and Schwab, R.M. (1995): "Finishing high school and starting college: do catholic schools make a difference?" *The Quarterly Journal of Economics,* 110, 941–974.

Every Woman Every Child. (2015): The Global Strategy for Women`s, Children`s and Adolescents` Health (2016-2030). Geneva: Every Woman Every Child.

Ferrara, E., Chong, A. and S. Duryea (2012): "Soap Operas and Fertility: Evidence from Brazil," *American Economic Journal: Applied Economics* 4(4), 1-31

Fichera, E. and Sutton, M. (2011): "State and self investments in health," *Journal of Health Economics* 30, 1164–1173.

Field, E., and A. Ambrus (2008): "Early marriage, age of menarche, and female schooling attainment in Bangladesh," *Journal of Political Economy,* 116(5), 881-930

Fletcher, J.M and B. Wolfe (2009): "Education and labour market consequences of teenage childbearing: Evidence using the timing of pregnancy: Outcomes and community fixed effects," *Journal of Human Resources* 44(2), 303-325.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S.R. and Berenson, G.S. (2002): "Relation of age at menarche to race, time period, and anthropometric dimensions: the Bogalusa heart study." *Pediatrics.*110 (4):e43.

Geronimus, A. T. (1987): "On Teenage Childbearing and Neonatal Mortality in the United States," *Population and Development Review* 13(2): 245-279

Geronimus, A and S. Korenman (1992): "The Socioeconomic Consequences of Teen Childbearing Reconsidered," *The Quarterly Journal of Economics*, 107(4), 1187-1214

Glynn, J.R., Kayuni, N., Floyd, S., Banda, E., Francis-Chizororo, M. (2010): "Age at menarche, schooling, and sexual debut in northern Malawi." *PLoS One,* 5(12).

Greene, W. (1997): "Econometric Analysis." Prentice-Hall, London.

Greene, W. H. (1998): "Gender Economics Courses in Liberal Arts Colleges: Further Results," *Journal of Economic Education,* 29, 291–300.

Greene, W.H. (2012): "Econometric Analysis," seventh ed. Prentice Hall, Upper Saddle River, NJ.

Gruber, J. 2001. "Risky Behavior Among Youths: An Economic Analysis, Introduction." In Gruber, J. (ed). *Risky Behavior Among Youths: An Economic Analysis. Chicago:* University of Chicago Press.

Guilkey, D. K. and Lance, P. M. (2014): "Program Impact Estimation with Binary Outcome Variables: Monte Carlo Results for Alternative Estimators and Empirical Examples." In Sickles, R.C. & Horrace, W.C. (eds.) *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications.* Springer Science and Business Media: New York.

Guo, R., Li, H., Yi, J. and J. Zhang, (2018): "Fertility, household structure, and parental labour supply: Evidence from China," *Journal of Comparative Economics*, 46, 145-156.

Han, S and Lee, S. (2019): "Estimation in a Generalization of Bivariate Probit Models with Dummy Endogenous Regressors," Working Paper,

Han, S. and Vitlacil, E. (2017): "Identification in a generalization of bivariate probit models with dummy endogenous regressors," *Journal of Econometrics*, 199, 63–73

Han, S. and E. Vitlacil (2017). "Identification in a generalization of bivariate probit models with dummy endogenous regressors," *Journal of Econometrics*, 199, 63–73.

Hajivassiliou, V. and P. Ruud. 1994. "Classical estimation methods for LDV models using simulation". In *Handbook of Econometrics*, eds. R. Engle and D. McFadden, vol. IV, 2383–2441. Amsterdam: North-Holland.

Heckman, J. J. (1978). "Dummy Endogenous Variables in a Simultaneous Equation System." *Econometrica*, 46(4): 931-959.

Herrera-Almanza, C. and D. E. Sahn (2018): "Early Childbearing, School Attainment, and Cognitive Skills: Evidence From Madagascar," *Demography*, *Forthcoming*

Heath, R. (2017): "Fertility at work: Children and women's labour market outcomes in urban Ghana," *Journal of Development Economics*, 126, 190-2014

Hoffman, S.D. (2015): "Teen Childbearing and Economics: A Short History of a 25-Year Research Love Affair," *Societies, 5*, 646-663

Holly, A., L. Gardiol, G. Domenighetti, and Bisig, B. (1998): "An econometric model of health care utilization and health insurance in Switzerland," *European Economic Review*, 42, 513–522.

Holmlund, H. (2005): "Estimating Long-Term Consequences of Teenage Childbearing: An Examination of the Siblings Approach," *Journal of Human Resources,* 3, **716-743**

Hotz, V.J., McElroy, S.W., and S.G. Sanders (2005): "Teenage childbearing and its life cycle consequences: Exploiting a natural experiment," *Journal of Human Resources* 40(3), 683-715

Hutchinson, A. and P. O'Leary (2016): "Young mothers in Islamic contexts: Implications for social work and social development," *International Social Work,* 59(3) 343–358

Jacobsen, J. P., Pearce, J. W. and J. L Rosenbloom (1999):" The Effects of Childbearing on Married Women's Labour Supply and Earnings: Using Twin Births as a Natural Experiment," *The Journal of Human Resources,* 34(3), 449-474

Jensen, R. and R. Thornton (2003): "Early female marriage in the developing," *Gender and Development*, 11(2), 9-19

Jones, A. (2007): "Identification of treatment effects in Health Economics," Health Economics, 16, 1127–1131.

Kane, J., Morgan, F., Harris, K .M and D. Guilkey (2013): "The Educational Consequences of Teen Childbearing," *Demography,* 50(6), 2129-2150.

Kaplowitz, P. B., Slora, E. J., Wasserman, R.C., Pedlow, S. E. & M. E. Herman-Giddens (2001): "Earlier onset of puberty in girls: relation to increased body mass index and race," *Pediatrics* 108, 347–353.

Karapanou, O. and A. Papadimitriou (2010): "Determinants of Menarche." *Reproductive Biology and Endocrinology,* 8(115), 1-8

Keane, M. P. (1994): "A computationally practical simulation estimator for panel data." *Econometrica* 62: 95−116.

Kelly, Y., Zilanawala, A., Sacker, A, et al. "Early puberty in 11-year-old girls: Millennium Cohort Study findings." *Archives of Disease in Childhood* 2017; 102: 232–237.

Klepinger, D., Lundberg, S. and R. Plotniek (1999): "How Does Adolescent Fertility Affect the Human Capital and Wages of Young Women?," *The Journal of Human Resources,* 421-449.

Koziel, S. & E. A. Jankowska (2002): "Effect of low versus normal birth weight on menarche in 14-year-old Polish girls," *Journal of Paediatrics and Child Health*, 38, 268–271.

Lai T. C., Leung, G. M. & C. M. Schooling (2016): “Maternal Age of Menarche and Blood Pressure in Adolescence: Evidence from Hong Kong’s “Children of 1997” Birth Cohort,” PLoS ONE 11 (7)

Lang, K. (2007): "The Economic Consequences are not what you think," *The Milken Institute review,* 44-53.

Lang, K., and Weinstein, R. (2015):” The Consequences of Teenage Childbearing Before Roe v. Wade,” *American Economic Journal: Applied Economics,* 7(4), 169-197

Lee, D (2010):” The Early Socioeconomic Effects of Teenage Childbearing: A propensity score matching approach,” *Demographic Research*, 23(25)

Levine, D. and G. Painter (2003): “The Schooling Costs of Teenage Out-of-Wedlock Childbearing: Analysis with a Within-School Propensity-Score-Matching Estimator,” *Review of Economics and Statistics,* 85, 884-900

Li, C., Poskitt, D.S and Zhao, X. (2019): “The bivariate probit model, maximum likelihood estimation, pseudo true parameters and partial identification,” *Journal of Econometrics* 209, 94–113.

Lundblad, M.W. and Jacobsen, B.K. (2017): The reproducibility of self-reported age at menarche: The Tromsø Study. B*MC Women's Health*, 17:62.

Maddala, G. S. (1983): “Limited Dependent and Qualitative Variables in Econometrics,” Cambridge: Cambridge University Press.

Maddala, G. and L.F. Lee. (1976): “Recursive models with qualitative endogenous variables.” *Annals of Economic and Social Measurement* 5 (4), 525–545.

Marchetta, F. and D. Sahn (2015): “The Role of Education and Family Background in Marriage, Childbearing, and Labour Market Participation in Senegal,” *Economic Development and Cultural Change,* 369-403.

Milligen, B. A.,Vogelzangs, N., Smit, J. H. & B. W. Penninx (2014): “Hemoglobin levels in persons with depressive and/or anxiety disorders,” *Journal of Psychosomatic Research*, 76, 317-321.

Mmari, K. and S. Sabherwal. (2013): “A Review of Risk and Protective Factors for Adolescent Sexual and Reproductive Health in Developing Countries: An Update.” *Journal of Adolescent Health*, 53(5), 562–572. DOI: 10.1016/j.jadohealth.2013.07.018.

Monfardini, C. and Radice, R. (2008): “Testing Exogeneity in the Bivariate Probit Model: A Monte Carlo Study,” O*xford Bulletin of Economics and Statictis,* 70, 271–282.

Mourifié I. and R. Méango (2014). "A note on the identification in two equations probit model with dummy endogenous regressor," *Economics Letters*, 125, 360-363.

Morris, S. (2007): "The impact of obesity on employment," *Labour Economics* 14(3), 413–433.

Narita, R. and M. Diaz (2016): "Teenage motherhood, education, and labour market outcomes of the mother: Evidence from Brazilian data, "*Economi*a, 17, 238–252.

Neal, D. (1997): "The Effects of Catholic Secondary Schooling on Educational Achievement," *Journal of Labor Economics*, 15, 98–123.

Neal, S., Matthews, Z., Frost, M, et al. (2012): "Childbearing in adolescents aged 12–15 years in low resource countries: a neglected issue. New estimates from demographic and household surveys in 42 countries." *Acta Obstetrics Gynecology Scandinavia*, 91: 1114–18.

Nevo, A., and A. Rosen. (2012): "Identification with imperfect instruments." *Review of Economics and Statistics* 94: 659–671.

Nour, N. (2006): "Health Consequences of Child Marriage in Africa." *Emerging Infectious Diseases*, 12 (11): 1644-1649. doi: 10.3201/eid1211.060510.

Opare-Addo, P.M., Stowe, M., Ankobea-Kokroe, F. & T. Zheng (2012): "Menarcheal and pubertal development and determining factors among schoolgirls in Kumasi, Ghana," *Journal of Obstetrics and Gynaecology*, 32, 159–165.

Oreopoulos, P. (2007). "Do Dropouts Drop Out Too Soon? Wealth, Health, and Happiness From Compulsory Schooling." *Journal of Public Economics,* 91:2213–29.

Pierce, M.B., Kuh, D. & R. Hardy (2012): "The role of BMI across the life course in the relationship between age at menarche and diabetes, in a British Birth Cohort," *Diabetic Medicine*, 29, 600–603.

Pradhan., R, Wynter, K., Fisher, J. (2015): "Factors associated with pregnancy among adolescents in low-income and lower middle-income countries: a systematic review." *Journal of Epidemiology and Community Health*, 69: 918–924.

Raj, A., Saggurti, N., Balaiah, D., & Silverman, J. G. (2009): "Prevalence of child marriage and its effect on fertility and fertility-control outcomes of young women in India: a cross-sectional, observational study." *The Lancet*, 373(9678):1883-1889.

Rascon-Ramirez, E. G. (2014). Teenage Pregnancy and Motherhood in England: Do parents' educational expectations matter? PhD manuscript.

Ranchhod V., Lam, D., Leibbrandt, and L. Marteleto (2011): "Estimating the Effect of Adolescent Fertility on Educational Attainment in Cape Town Using a Propensity Score Weighted Regression," Working Paper

Rees (1995): "The age of menarche," *Orgyn.* 1995(4), 2-4.

Reinhold, S & Woutersen, T. (2009): "Endogeneity and Imperfect Instruments: Estimating Bounds for the Effect of Early Childbearing on High School Completion," University of Arizona Department of Economics Working Paper.

Ribar, D.C. (1994): "Teenage Fertility and High School Completion," *The Review of Economics and Statistics*, 413-425.

Roodman, R. (2009): "Estimating fully observed recursive mixed-process models with cmp." Center for Global Development, Working Paper N. 168.

Rosenzweig, M. R., and K. I. Wolpin (1980): "Life-Cycle Labour Supply and Fertility: Causal Inference from Household Models," *Journal of Political Economy*, 88(2), 328–348.

Rosenbaum, P. and D. Rubin (1983): "The Central Role of the Propensity Score in Observational Studies for Causal Effects," *Biometrika*, 70(1) 41-55.

Schultz, T. P (2008): "Population Policies, Fertility, Women's Human Capital, and Child Quality," *In Handbook of Development Economics*, 4, 3249–3303

Sekhri, S. & Debnath, S. (2014). "Intergenerational Consequences of Early Age Marriages of Girls: Effect on Children's Human Capital." *Journal of Development Studies,* 50(12).

Sommer, M. (2013): Menarche: A Missing Indicator in Population Health from Low-Income Countries. *Public Health Rep.* 128(5): 399–401.

Squires, H., Hernandez Alava, M., Payne, N., Blank, L., Baxter, S. and Preston, L. (2012): "How much does teenage parenthood affect long term outcomes? A systematic review," Discussions paper, University of Sheffield.

Sunder, N. (2016):" Marriage Age, Social Status and Intergenerational Effects in Uganda," Department of Economics, Cornell University

Szwed, A., John, A., Czapla, Z. and M. Kosinska (2013): "Influence of socioeconomic factors on age at menarche of Polish girls," *Anthrop. Anz.*, 70(4), 455–470

Trussell, J. and A. R. Pebley (1984): "The Potential Impact of Changes in Fertility on Infant, Child and Maternal Mortality," *Studies in Family Planning*, 15(6), 267-280

UNFPA (2013a). "Adolescent Pregnancy: A Review of the Evidence," New York

UNFPA (2013b). "Motherhood in Childhood: Facing the Challenge of Adolescent Pregnancy," New York.

UNFPA. (2015): "Girlhood, not motherhood: Preventing adolescent pregnancy." New York: UNFPA; 2015.

Urdinola, B. P. and C. Ospino. (2015): "Long-term consequences of adolescent fertility: The Colombian case," *Demographic Research*, 32(55), 1487-1518

Vere, J. P. (2011): "Fertility and parents' labour supply: new evidence from US census data," *Oxford Economic Papers*, 63, 211–231.

Vulser H., Wiernik E., Hoertel N., Thomas F., Pannier B., Czernichow S., Hanon O., Simon T., Simon J.-M., Danchin N., Limosin F. & C. Lemogne (2016): "Association between depression and anemia in otherwise healthy adults," *Acta Psychiatrica Scandinavica*, 134, 150-160.

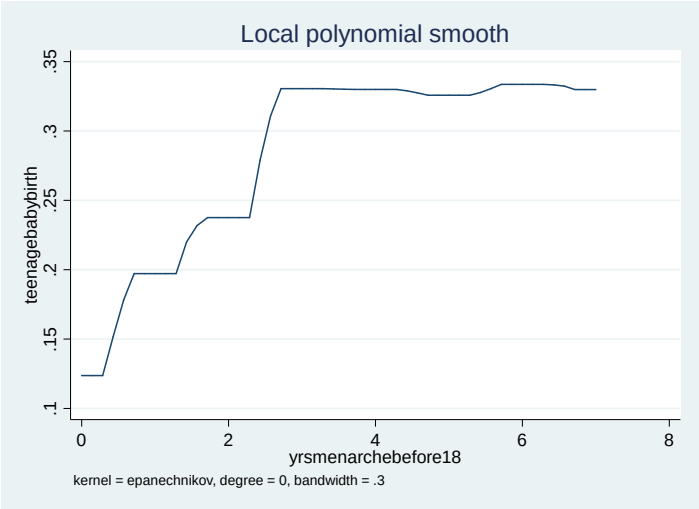
Waite, L. J., and K. A. Moore. (1978): "The Impact of an Early First Birth on Young Women's Educational Attainment," *Social Forces*, 56(3): 845–865.

Wilde, J. (2000): "Identification of multiple equation probit models with endogenous dummy regressors." *Economics Letters* 69, 309–312.

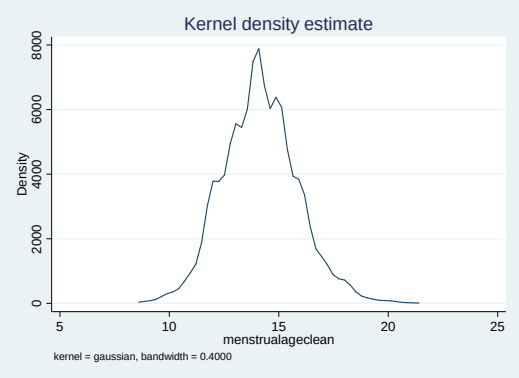
World Health Organization. (2008): "Why is giving special attention to adolescents important for achieving Millennium Development Goal 5?" Factsheet. Geneva: WHO.

Yermachenko, A. and Volodymyr, D. (2014): "Nongenetic Determinants of Age at Menarche: A Systematic Review," *Journal of Biomedicine and Biotechnology*, DOI: 10.1155/2014/371583.

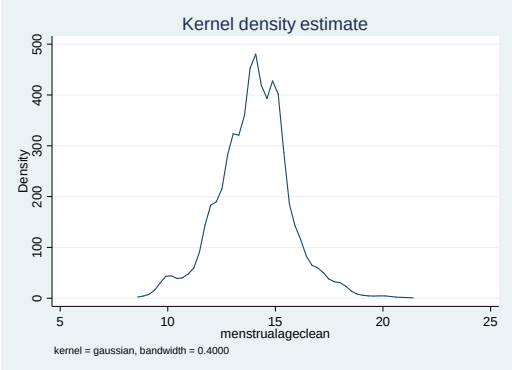
Appendix Figure 1A: Local polynomial for years pre-18 menarche and likelihood of becoming a teenage mom



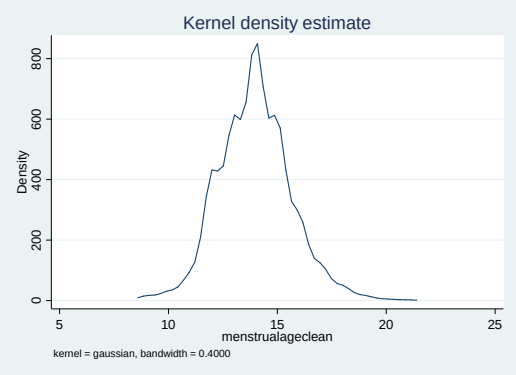
Appendix Figures 1B: Kernel density graphs for age of menarche, full sample and countries



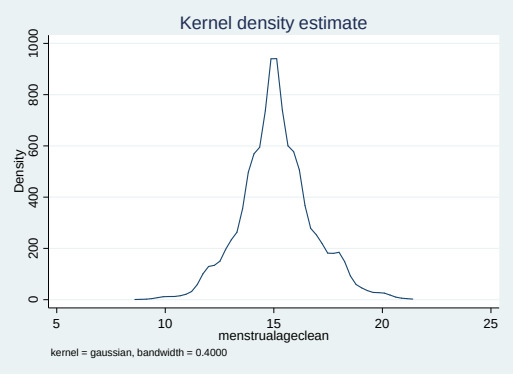
Age of menarche, full sample



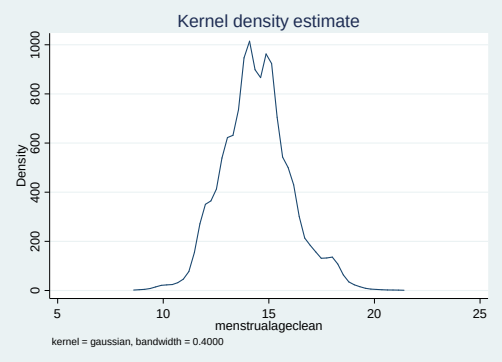
Age of menarche, Cameroon



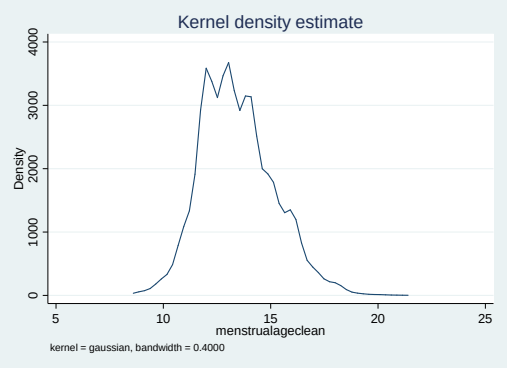
Age of menarche, Gabon



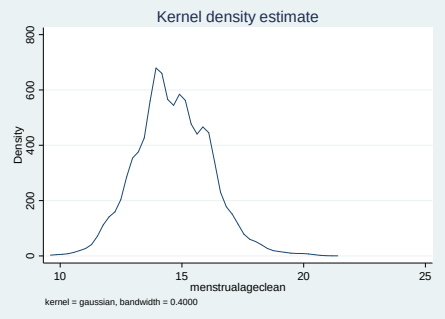
Age of menarche, Ghana



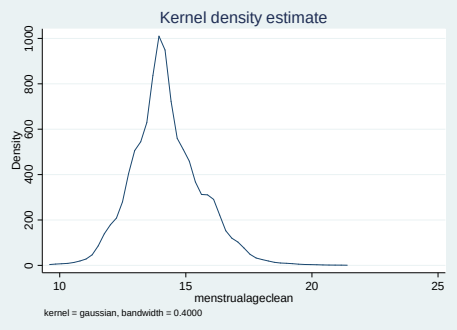
Age of menarche, Uganda



Age of menarche, Philippines



Age of menarche, Kyrgyzstan



Age of menarche, Uzbekistan

Appendix Table 1: Means and proportions for key variables

	Mean	Min	Max
Teenage motherhood	0.25	0.00	1.00
Years of education	8.03	0.00	15.00
Literacy	0.77	0.00	1.00
Paid work	0.53	0.00	1.00
Works currently	0.63	0.00	1.00
Works currently - excluding work for family	0.54	0.00	1.00
Age of woman	35.70	25.00	49.00
Urban	0.46	0.00	1.00
Average parental years of education in community	7.94	0.00	17.00
Number of household members	6.28	1.00	48.00
Male household head	0.81	0.00	1.00
Number of children born	4.06	1.00	18.00
Age at first marriage	19.96	8.00	40.00
Years of fertility prior to 18 (menarche)	4.05	0.00	8.00
Years of sex after menarche and before 18	0.96	0.00	8.00
Average years of sex before 18	1.14	0.00	2.59
Access to abortion	0.28	0.00	1.00
Access to contraception	0.32	0.00	0.86

Appendix Table 2: Means and proportions for key list of variables for seven countries

	Cameroon	Uganda	Ghana	Gabon	Phillippines	Uzbekistan	Krygzstan
Teenage motherhood	0.52	0.50	0.34	0.56	0.15	0.07	0.07
Years of education	3.20	4.00	5.23	6.91	9.38	10.59	10.89
Literacy	0.30	0.45	0.45	0.76	0.91	0.94	0.96
Paid work	0.56	0.56	0.82	0.49	0.47	0.54	0.55
Works currently	0.71	0.83	0.89	0.58	0.55	0.58	0.56
Works currently - excluding work for family	0.58	0.64	0.82	0.57	0.45	0.57	0.48
Age of woman	33.92	34.10	35.49	34.79	36.56	35.22	35.78
Urban	0.40	0.14	0.33	0.77	0.53	0.39	0.34
Average parental education in community	3.74	5.68	6.36	7.34	8.44	10.81	10.55
Catholic	0.34	0.42	0.14	0.57	0.80	0.00	0.00
Protestant	0.27	0.41	0.62	0.28	0.05	0.05	0.11
Muslim	0.24	0.11	0.11	0.05	0.05	0.94	0.86
Other	0.00	0.06	0.06	0.02	0.10	0.00	0.00
No religion	0.15	0.00	0.08	0.08	0.00	0.01	0.03
Number of household members	8.97	6.65	5.30	8.22	5.82	6.14	5.80
Male household head	0.87	0.71	0.61	0.70	0.89	0.82	0.78
Average years of parental education in community	3.74	5.68	6.36	7.34	8.44	10.81	10.55
Number of children born	5.17	5.51	4.22	4.51	3.62	3.68	3.57
Age at first marriage	16.49	17.49	18.81	19.34	21.25	19.82	20.19
yrsmenarchebefore18	3.99	3.59	2.90	4.02	4.55	3.77	3.37
Years of sex after menarche and before 18	2.59	1.97	1.36	2.37	0.45	0.25	0.17
Average years of sex before 18	1.53	1.62	1.48	1.61	0.97	0.72	0.81
Access to abortion	0.31	0.24	0.24	0.38	0.22	0.31	0.56
Access to contraception	0.06	0.21	0.15	0.17	0.37	0.56	0.52
Observations	1546	3404	2782	2716	14617	2476	2300

Appendix Table 3: Comparing characteristics and outcomes for teenage mothers and other mothers

	Other mother	Teenage mother	P-value
Years of education	8.77	5.06	0.00
Literacy	0.80	0.54	0.00
Work	0.63	0.70	0.00
Paid work	0.56	0.57	0.73
Poverty	0.22	0.43	0.00
Average parental education for community	8.56	6.28	0.00
Share of husbands in community who supports family planning	0.69	0.44	0.00
Age of marriage	20.76	16.38	0.00
Years before 18 (menarche)	3.85	4.35	0.00
Muslim	0.34	0.16	0.00
Urban	0.47	0.42	0.00
Live in an African country	0.33	0.80	0.00

Appendix Table 4: Examining the impact of teen marriage on years of education, literacy and paid work

	OLS years of education	IV years of education	Bivariate probit literacy	Bivariate probit paid work
Teen bride	-1.48***	-2.29***	-0.21***	-0.29***
Age of woman	-0.05***	-0.05***	-0.004***	0.008***
Urban	0.56***	0.52***	0.05***	0.02*
Average parental education in community	0.52***	0.51***	0.03***	
Observations	31110	31110	31110	31110

*Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

Appendix Table 5: Robustness checks for impact of teenage motherhood on years of education and literacy

	OLS Years of education	IV Years of education	Bivariate probit for literacy
Teenage motherhood	-1.18***	-3.23***	-0.19***
Age of woman	-0.03***	-0.03***	-0.004***
Urban	0.66***	0.59***	0.06***
Average parental education	0.62***	0.58***	0.03***
Weight	0.02***	0.02***	0.002***
Height	0.02***	0.01**	-0.0001
Observations	11377	11377	11377

*Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

Appendix Table 6: Robustness check: First-stage regression of Teenage Motherhood

	Coef.	P-value
Years of menarche before 18	0.03	0.00
Age of woman	-0.0001	0.84
Urban	-0.02	0.00
Average parental years of education for community	-0.03	0.00
Weight	0.001	0.00
Height	-0.002	0.00
Diagnostics	**Score**	**P-value**
Partial R-squared of excluded instruments		
Cragg-Donald N*minEval stat.	218.76	0.00
Anderson canon. corr. likelihood ratio stat	98.50	0.00
Number of observations	11377	
Number of clusters	257	

Appendix Table 7: Robustness checks: Impact of teenage motherhood on years of education and literacy

	OLS Years of education	IV Years of education	Bivariate probit for literacy
Teenage motherhood	-1.20***	-2.98***	-0.15***
Age of woman	-0.02***	-0.02***	-0.002***
Urban	0.45***	0.41***	0.06***
Average parental education	0.76***	0.71***	0.03***
Weight	0.01***	0.01***	0.002***
Height	0.02***	0.01**	-0.0004
Haemoglobin	0.02	0.03	0.0002
Observations	7988	7988	7988

Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01

Appendix Table 8: Robustness checks - First-stage regression of teenage motherhood

	Coef.	P-value
Years of menarche before 18	0.02	0.00
Age of woman	0.005	0.49
Urban	-0.02	0.02
Average parental years of education for community	-0.03	0.00
Weight	0.001	0.00
Height	-0.002	0.01
Haemoglobin	0.003	0.20
Diagnostics	**Score**	**P-value**
Partial R-squared of excluded instruments		
Cragg-Donald N*minEval stat.	90.84	0.00
Anderson canon. corr. likelihood ratio stat	66.04	0.00
Number of observations	7988	
Number of clusters	208	

Appendix Table 9: Robustness checks - Impact of teenage motherhood on years of education and literacy

	OLS Years of education	IV Years of education	Bivariate probit for literacy
Teenage motherhood	-1.20***	-3.09***	-0.16***
Age of woman	-0.02***	-0.02***	-0.003***
Urban	0.47***	0.44***	0.06***
Average parental education	0.76***	0.71***	0.03***
BMI	0.03***	0.04***	0.005***
Anaemia	-0.08	-0.10	0.005
Observations	7988	7988	7988

*Notes: All models include fixed effects for religious affiliation, country and ethnic group membership, * p<0.10 ** p<0.05 *** <0.01*

Appendix Table 10: Robustness checks First-stage regression of teenage motherhood

	Coef.	P-value
Years of menarche before 18	0.02	0.00
Age of woman	0.0004	0.51
Urban	-0.03	0.04
Average parental years of education for community	-0.03	0.00
BMI	0.003	0.00
Anaemia	-0.01	0.28
Diagnostics	**Score**	**P-value**
Partial R-squared of excluded instruments		
Cragg-Donald N*minEval stat.	71.73	0.00
Anderson canon. corr. likelihood ratio stat	51.91	0.00
Number of observations	7988	
Number of clusters	208	

Appendix Table 11: Robustness checks - Impact of teenage motherhood paid work

	Bivariate probit paid work	Bivariate probit paid work	Bivariate probit paid work	Bivariate probit paid work
Teenage motherhood	-0.17**	0.11	-0.12*	0.04
Age of woman	0.007***	0.008***	0.007***	0.008***
Urban	0.04*	0.02	0.04**	0.02
Woman education	-	0.02***	-	0.02***
Weight	0.001*	0.0003	-	-
Height	-0.002	-0.002	-	-
Haemoglobin	0.0006	-0.001	-	-
BMI	-	-	0.003***	0.002
Observations	7988	7988	11377	11377

Notes: All models include fixed effects for religious affiliation, country and ethnic group membership
* p<0.10 ** p<0.05 *** p<0.01